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DATA PAPER

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A database on the distribution of butterflies (Lepidoptera) in northern Belgium (Flanders and the Brussels Capital Region)

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This paper describes version 1.3 of this resource: http://dataset.inbo.be/dagvlinders-inbo-occurrences&v=1.3

Vanreusel W, Herremans M, Vantieghem P, Gielen K, Vlinderwerkgroep Natuurpunt, all butterfly recorders (2016): Waarnemingen.be - Butterfly occurrences in Flanders and the Brussels Capital Region, Belgium. Natuurpunt. Dataset/Occurrence. http://doi.org/10.15468/ezfbee Data paper: http://dx.doi.org/10.3897/zookeys.585.8019

This paper describes version 1.2 of this resource: http://dataset.inbo.be/dagvlinders-natuurpunt-occurrences&v=1.2

Abstract

In this data paper, we describe two datasets derived from two sources, which collectively represent the most complete overview of butterflies in Flanders and the Brussels Capital Region (northern Belgium). The first dataset (further referred to as the *INBO dataset* – http://doi.org/10.15468/njgbmh) contains

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761,660 records of 70 species and is compiled by the Research Institute for Nature and Forest (INBO) in cooperation with the Butterfly working group of Natuurpunt (Vlinderwerkgroep). It is derived from the database Vlinderdatabank at the INBO, which consists of (historical) collection and literature data (1830-2001), for which all butterfly specimens in institutional and available personal collections were digitized and all entomological and other relevant publications were checked for butterfly distribution data. It also contains observations and monitoring data for the period 1991-2014. The latter type were collected by a (small) butterfly monitoring network where butterflies were recorded using a standardized protocol. The second dataset (further referred to as the *Natuurpunt dataset* – http://doi.org/10.15468/ezfbee) contains 612,934 records of 63 species and is derived from the database http://waarnemingen.be, hosted at the nature conservation NGO Natuurpunt in collaboration with Stichting Natuurinformatie. This dataset contains butterfly observations by volunteers (citizen scientists), mainly since 2008. Together, these datasets currently contain a total of 1,374,594 records, which are georeferenced using the centroid of their respective 5 × 5 km² Universal Transverse Mercator (UTM) grid cell. Both datasets are published as open data and are available through the Global Biodiversity Information Facility (GBIF).

Keywords
Butterflies, distribution, collection, literature, citizen science, observations, monitoring

Data published through

INBO dataset: http://doi.org/10.15468/njgbmh
(http://www.gbif.org/dataset/7888f666-f59e-4534-8478-3a10a3bfee45)
Natuurpunt dataset: http://doi.org/10.15468/ezfbee
(http://www.gbif.org/dataset/1f968e89-ca96-4065-91a5-4858e736b5aa)

Rationale

Butterflies are among the best studied insects in the world and have always attracted the attention of both professional researchers, amateur naturalists, butterfly collectors, and the wider public (Kühn et al. 2008). Butterflies are widely considered as interesting study systems for ecology, evolution, behaviour, and conservation biology (e.g., Watt and Boggs 2003). Many butterflies have been collected and subsequently stored in museum or private collections. Furthermore, entomologists have often published lists of observed species during excursions to special habitats or have made overviews of regional or national butterfly faunas. In Belgium, entomology in general and lepidopterology in particular, have a long tradition with the first faunas already published only seven years after its independence in 1830 (De Selys-Longchamps 1837). Since then, several authors have updated the Belgian butterfly fauna based on collections or observations (e.g., Hackray et al. 1969; De Prins 1998). In 1991, the youth and nature organization Jeugdbond voor Natuur en Milieu (JNM) launched a butterfly project with the aim to publish a distribution atlas of the butterflies of Flanders, northern Belgium (Daniëls 1991). To do so, a first step consisted of collecting all historical collection and

literature data. Secondly, a working group was organised in cooperation between JNM, De Wielewaal (which later became Natuurpunt) and the INBO that set up a citizen science project to obtain as many butterfly observations with a good spatial coverage over Flanders. The data gathered during this project (period 1991-1998) were used to compile a first Red List (Maes and Van Dyck 2001) and a distribution atlas of butterflies in Flanders, including the Brussels Capital Region (Maes and Van Dyck 1999). Recently, both the Red List (Maes et al. 2012) and the distribution atlas (Maes et al. 2013) were updated using recent distribution data recorded through www.waarnemingen.be, a data portal launched by Natuurpunt, the largest nature conservation NGO in Belgium, where citizen-scientists can store and keep track of their recordings. Here, we publish both the historical and the more recent data used for the Red List and the distribution atlases as a data paper on a UTM grid cell resolution of 5 × 5 km².

Taxonomic coverage

The datasets cover all 67 indigenous and 3 regular migrant butterfly species (*Colias croceus*, *Colias hyale*, *Vanessa cardui*). In the INBO dataset vagrant or doubtful species (*Apatura ilia*, *Arethusana arethusa*, *Boloria dia*, *Brenthis ino*, *Coenonympha arcania*, *Colias alfacariensis*, *Colias palaeno*, *Cupido argiades*, *Danaus plexippus*, *Erebia aethiops*, *Erebia ligea*, *Erebia medusa*, *Hamearis lucina*, *Iphiclides podalirius*, *Lampides boeticus*, *Lasiommata maera*, *Limenitis populi*, *L. reducta*, *Lycaena dispar*, *Lycaena helle*, *Lycaena hippothoe*, *Lycaena virgaureae*, *Melitaea aurelia*, *Pontia daplidice*) and introduced species (*Cacyreus marshalli* and *Polyommatus damon*) were excluded because no evidence of the observation was available. In the Natuurpunt dataset, however, eight vagrant species with photographic evidence, that most likely spontaneously reached Flanders were included (*Apatura ilia*, *Brenthis ino*, *Cupido argiades*, *Iphiclides podalirius*, *Lampides boeticus*, *Nymphalis xanthomelas*, *Polyommatus coridon* and *Pontia daplidice*). Three additional species (*Aporia crataegi*, *Argynnis adippe* and *A. aglaja*) are considered as indigenous species, but recent observations are all vagrant individuals. Nomenclature is according to Fauna Europaea (http://www.faunaeur.org/full_results.php?id=7).

Taxonomic ranks

Kingdom: Animalia

Phylum: Arthropoda, **Subphylum:** Hexapoda, **Class:** Insecta, **Order:** Lepidoptera, **Superfamilies:** Hesperoidea, Papilioidea, **Families:** Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, **Subfamilies:** Apaturinae, Coliadinae, Dismorphiinae, Heliconiinae, Heteropterinae, Hesperiinae, Limenitidinae, Lycaeninae, Melitaeinae, Nymphalinae, Papilioninae, Pierini, Polyommatinae, Pyrginae, Satyrinae, Theclinae, **Genera:** *Aglais*, *Anthocharis*, *Apatura*, *Aphantopus*, *Aporia*, *Araschnia*, *Argynnis*, *Aricia*, *Boloria*, *Callophrys*, *Carcharodus*, *Carterocephalus*,

Celastrina, *Coenonympha*, *Cupido*, *Cyaniris*, *Erynnis*, *Euphydryas*, *Favonius*, *Gonepteryx*, *Hesperia*, *Heteropterus*, *Hipparchia*, *Issoria*, *Lasiommata*, *Leptidea*, *Limenitis*, *Lycaena*, *Maniola*, *Melitaea*, *Melanargia*, *Nymphalis*, *Ochlodes*, *Papilio*, *Pararge*, *Phengaris*, *Pieris*, *Plebejus*, *Polygonia*, *Polyommatus*, *Pyrgus*, *Pyronia*, *Satyrium*, *Spialia*, *Thecla*, *Thymelicus*, *Vanessa*

Species: Table 1 gives an overview of the species, together with the number of records present in the respective datasets.

Common names: Butterflies

Table 1. The number of records per species in the two datasets and the sum of the records in both datasets. v = observations with photographic evidence, but the species most probably do not have populations in Flanders. †indicates that a species is considered as extinct in Flanders; the year of extinction is also given. Observations after the year of extinction are considered as vagrant individuals. M: regular migrant species, (M): the species is indigenous, but the regional population is supplemented by migrant individuals.

Species name	INBO	Natuurpunt	Total
Aglais io	54,329	52,471	106,800
Aglais urticae	35,237	25,047	60,284
Anthocharis cardamines	15,689	17,393	33,082
Apatura ilia	-	4v	4
Apatura iris	141	304	445
Aphantopus hyperantus	8,156	7,636	15,792
Aporia crataegi†1960	120	2v	122
Araschnia levana	24,772	18,531	43,303
Argynnis adippe†1947	22	3v	25
Argynnis aglaja†1971	54	1v	55
Argynnis niobe†1977	21	-	21
Argynnis paphia	272	697	969
Aricia agestis	6,867	5,251	12,118
Boloria euphrosyne†1949	37	-	37
Boloria selene†1994	181	-	181
Brenthis ino	-	7v	7
Callophrys rubi	2,008	1,552	3,560
Carcharodus alceae	16	402	418
Carterocephalus palaemon	1,159	2,478	3,637
Celastrina argiolus	21,857	20,579	42,436
Coenonympha hero†1912	16	-	16
Coenonympha pamphilus	9,886	10,429	20,315
Coenonympha tullia†1994	70	-	70
Colias croceusM	3,380	12,762	16,142
Colias hyaleM	617	277	894
Cupido argiades	-	1v	1
Cupido minimus	82	43	125
Cyaniris semiargus	222	76	298
Erynnis tages	102	130	232
Euphydryas aurinia†1959	65	-	65

Species name	INBO	Natuurpunt	Total
Favonius quercus	2,217	3,051	5,268
Gonepteryx rhamni	20,011	22,357	42,368
Hesperia comma	145	471	616
Heteropterus morpheus[†1995]	29	-	29
Hipparchia semele	4,157	5,160	9,317
Hipparchia statilinus[†1930]	11	-	11
Iphiclides podalirius	-	5[v]	5
Issoria lathonia	2,794	3,216	6,010
Lampides boeticus	-	44[v]	44
Lasiommata megera	4,089	1,882	5,971
Leptidea sinapis	144	585	729
Limenitis camilla	1,154	2,323	3,477
Limenitis populi[†1957]	14	-	14
Lycaena phlaeas	16,393	15,246	31,639
Lycaena tityrus	303	263	566
Maniola jurtina	35,117	31,782	66,899
Melanargia galathea	53	23	76
Melitaea athalia[†1968]	80	-	80
Melitaea cinxia	300	466	766
Melitaea diamina[†1954]	28	-	28
Nymphalis antiopa	240	63	303
Nymphalis polychloros	323	362	685
Nymphalis xanthomelas	-	5[v]	5
Ochlodes sylvanus	11,484	15,660	27,144
Papilio machaon	10,322	8,927	19,249
Pararge aegeria	65,290	56,129	121,419
Phengaris alcon	441	342	783
Phengaris teleius[†1980]	136	-	136
Pieris brassicae	45,713	22,030	67,743
Pieris napi	54,313	28,294	82,607
Pieris rapae	94,957	52,188	147,145
Plebejus argus	1,436	1,711	3,147
Plebejus idas[†1984]	15	-	15
Polygonia c-album	33,660	36,058	69,718
Polyommatus coridon	-	12[v]	12
Polyommatus icarus	20,269	21,186	41,455
Pontia daplidice	-	3[v]	3
Pyrgus armoricanus[†1952]	18	-	18
Pyrgus malvae	589	527	1116
Pyronia tithonus	31,771	21,184	52,955
Satyrium ilicis	397	617	1,014
Satyrium w-album	97	504	601
Spialia sertorius[†1937]	8	-	8
Thecla betulae	835	2,191	3,026
Thymelicus lineola	17,087	5,029	22,116

Species name	INBO	Natuurpunt	Total
Thymelicus sylvestris	1,012	387	1,399
Vanessa atalanta$^{(M)}$	69,965	55,306	125,271
Vanessa cardui^{M}	28,865	21,269	50,134
Total	761,660	612,934	1,374,594
N species	70	63	78
Number of grid cells surveyed	631	634	637
Number of different observers	1,697	3,856	

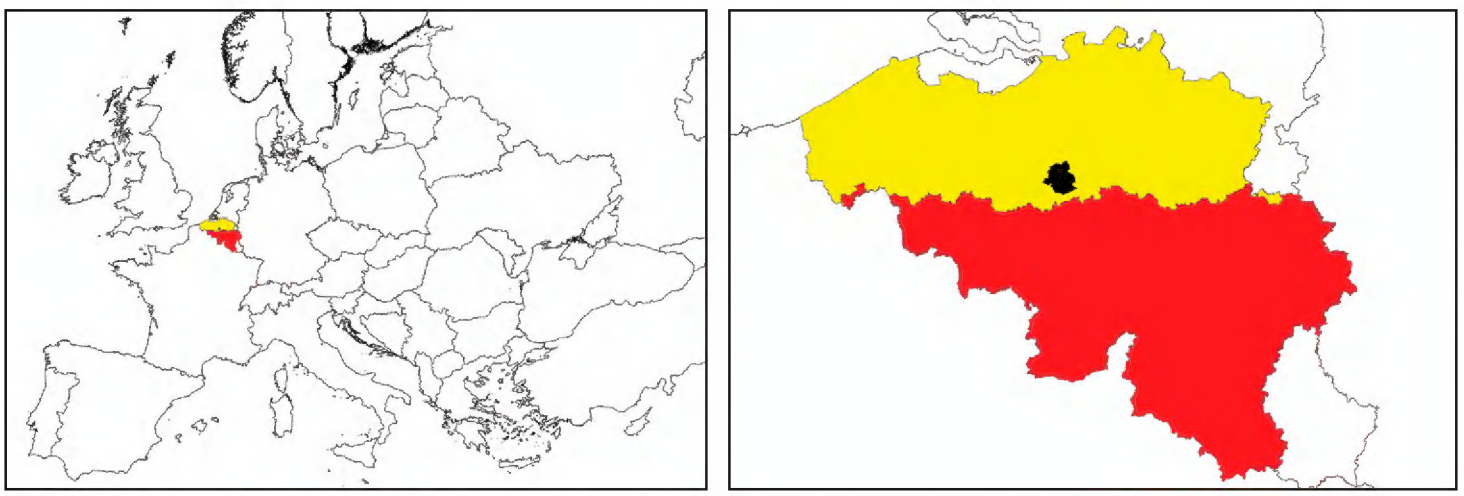

Figure 1. The location of Belgium in Europe (left) and the three administrative regions of Belgium (right): Flanders (yellow), the Brussels Capital Region (black) and Wallonia (red).

Geographic coverage

Flanders and the Brussels Capital Region

Flanders and the Brussels Capital Region cover an area of 13,522 km² and 162 km² respectively (13,684 km² in total – Figure 1). This area is situated in the northern of Belgium and represents 45% of the Belgian territory. Flanders is largely covered by agricultural land and urban areas while the Brussels Capital Region is mainly urban (Table 2). Both regions have a very high population density (Table 2).

Bounding box

50°40'48"N to 51°30'36"N latitude, 2°32'24"E to 5°55'12"E longitude

Georeferencing method

All distribution data of butterflies in Flanders and the Brussels Capital Region were attributed to grid cells of 5 × 5 km² of the Universal Transverse Mercator (UTM) projection (Figure 2). The centroids of the 5 × 5 km² grid cells were calculated using the

Table 2. Area of the main land use types in Flanders and the Brussels Capital Region in ha (ranked in descending order of percentage in both regions). Source: Biological Valuation Map Flanders and the Brussels Capital Region (Vriens et al. 2011).

Land use type	Flanders	Land use type	Brussels Capital Region
Agricultural land	702 276 (51%)	Urban areas	11 917 (73%)
Urban areas	411 144 (30%)	Woodlands	1988 (12%)
Woodlands	138 595 (10%)	Other green areas	1568 (10%)
Other green areas	39 516 (3%)	Agricultural land	544 (3%)
Water	32 008 (2%)	Water	185 (1%)
Semi-natural grasslands	15 315 (1%)	Semi-natural grasslands	27 (<1%)
Heathlands	8140 (<1%)	Marshes	17 (<1%)
Coastal dunes	1818 (<1%)	Heathlands	3 (<1%)
Marshes	1742 (<1%)		
Mud flats and salt marshes	1497 (<1%)		
Population density	474/km²		7210/km²

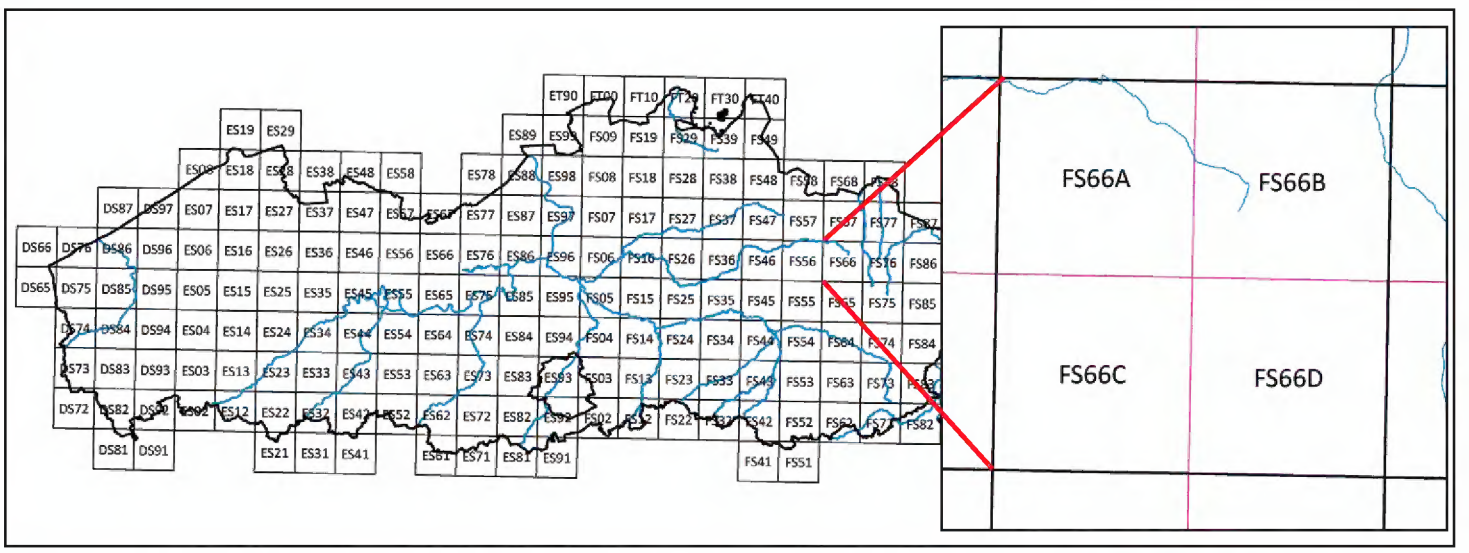

Figure 2. 10 × 10 km² UTM grid cells in Flanders and in the Brussels Capital Region. The partitioning of 10 × 10 km² UTM grid cells (left) into 5 × 5 km² UTM grid cells is shown on the right. The 5 × 5 km² UTM grid cells were used to georeference the distribution data in Flanders and the Brussels Capital Region.

WGS84 projection with a *coordinateUncertaintyInMeters* of 3,769 meters (Wieczorek et al. 2004).

In total, Flanders and the Brussels Capital Region cover 638 (622 with records) and 9 (all nine with records) grid cells, respectively. The grid cells without records only cover a very small area within Flanders.

Temporal coverage

The INBO dataset mainly covers the historical museum and literature records (since 1830), butterfly monitoring records (since 1991) and observations (until 2008) while the Natuurpunt dataset covers the recent observations (mostly since 2008). Between

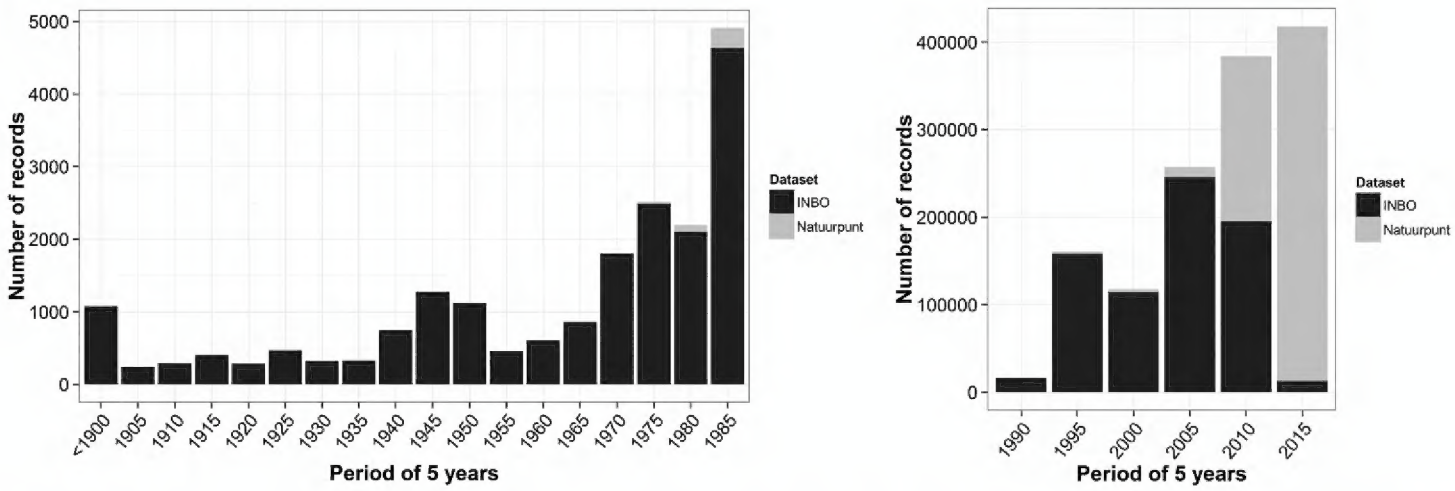

Figure 3. Number of collected records between 1830 and 1985 (left) and between 1986 and 2014 (right) in the two datasets (INBO and Natuurpunt). Each number on the x-axis stands for a period of 5 years (e.g., 1905 = 1901–1905, 1910 = 1906–1910, etc.). Note the different scales on the y-axis for both figures.

2000 and 2006, a butterfly survey project was organised in the province of West-Flanders (Cuvelier et al. 2007) and in the period 2006-2008, a similar project was undertaken in the Brussels Capital Region by the INBO on demand of Leefmilieu Brussel – BIM (Beckers et al. 2009). Both datasources were integrated in the INBO dataset. Since the introduction of the data portal www.waarnemingen.be for storing observations by the NGO Natuurpunt in 2008, the number of records has strongly increased and now reaches almost 150,000 records per year (Figure 3). The datasets will be updated on a yearly basis.

Methodology

Sampling methods

Butterfly distribution data were collected in four different ways: i) collection data, ii) literature data, iii) monitoring transect data and iv) observations.

Collection data were digitized from the following museum collections: Bosmuseum Groenendaal, Royal Institute for Natural Sciences (Brussels), Agricultural Faculty of Gembloux, Ghent university and the Antwerp Zoo. Furthermore, the private butterfly collections of the following people were also incorporated into the INBO dataset: A. Artoisenet, R. Bracke, A. Caljon, S. Cuvelier, A. De Boer, K. Desender, P. Halflants, D. Hilven, J. & T. Jaeken, M. Keirens, H. Kinders, P. & W. Pardon, W. Tips, W. Troukens, F. Turelinckx, O. Van De Kerckhove, R. Van Heuverswijn, B. Vandepitte, J. Vervaeke & R. Winnen. The source collection is indicated in the field *associatedReferences*.

Published observations were searched for in different literature sources (see section "References to literature checked for occurrence data" in the Suppl. material 1) and indicated in the field *associatedReferences*. Since most of the records in collections and in the literature were only reported at the municipality level, the UTM 5 × 5 km² grid cell of the centre of the municipality was attributed to the record.

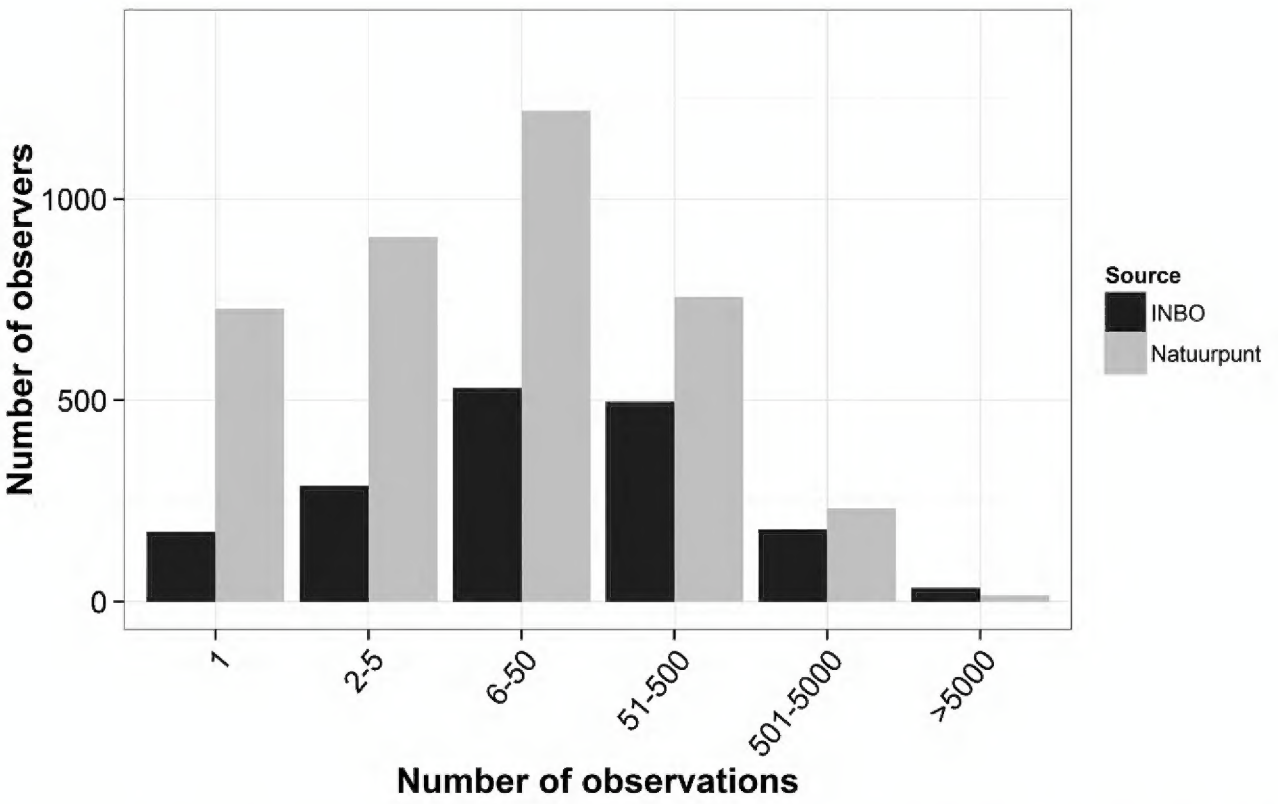

Figure 4. Frequency distribution of the observers per number of records in the datasets of INBO and Natuurpunt.

Butterfly monitoring counts were conducted along fixed transects of maximum 1 km, consisting of smaller sections, each with a homogeneous habitat (e.g., woodland, hay meadow, dry heathland – see van Swaay et al. 2008; van Swaay et al. 2011 for a detailed description of the monitoring method).

Observations (species, date, location, observer) were recorded by volunteers/citizen scientists and stored in the INBO dataset (mainly for the period 1991-2007, usually with a resolution of 1 × 1 km² or 5 × 5 km²) or in the Natuurpunt dataset. Since 2011, 69% of the records had a precision of 25m or less. Because of the increasing popularity of mobile apps using GPS readings in the field, this proportion increased with 5% per year to reach 77% in 2015. The number of observers in the INBO and the Natuurpunt datasets is given in Table 1. The frequency distribution of the recorders per number of records is given in Figure 4.

A list of references that used data described in this paper can be found in the section "Publications based on this dataset" in the Suppl. material 1.

Quality control

The data in both datasets were carefully verified by butterfly experts (including professional entomologists) taking collection specimens, the observer's species knowledge, added photographs and known species list of locations into account. The validation procedure from www.waarnemingen.be consists of an interactive procedure in which observers can be asked for additional information by a team of validators, after which

the validator manually adds a validation status. Records that are not manually validated are additionally checked by an automated validation procedure that takes into account the number of manually validated observations within a specified date and distance range. 11% of the butterfly records submitted to the data portal www.waarnemingen.be are supported by photographs. The validation status is indicated in the field *identificationVerificationStatus*.

Information withheld

In the original databases, the observer's name, the exact XY-coordinates and the toponym are known.

Datasets

Dataset description

The butterfly occurrence data are published as two separate Darwin Core Archives: 1) collection and literature data, observations and butterfly monitoring in Flanders and in the Brussels Capital Region (1830-2014) hosted at the Research Institute for Nature and Forest (INBO) and 2) recent observations (1974-2014) from the Natuurpunt data portal (www.waarnemingen.be). The data models used for both datasets are identical and can be merged easily. The INBO dataset contains 761,660 records and the Natuurpunt dataset 612,934 records totalling to almost 1.4 million records. The data compiled for the butterfly atlas of the Brussels Capital Region are marked as INBO/LB-BIM in the *ownerInstitutionCode* field in the INBO dataset.

The distribution of the number of records and species per grid cell for both datasets is given in Figure 5.

The data are standardized to Darwin Core (Wieczorek et al. 2012) with a custom SQL view on the original INBO and Natuurpunt butterfly database respectively. They were published using the GBIF Integrated Publishing Toolkit (Robertson et al. 2014) instance at the INBO (http://data.inbo.be/ipt). The Darwin Core terms (http://rs.tdwg.org/dwc/terms/) in the dataset at the time of publication are:

occurrenceID, *type*, *language*, *license*, *rightsHolder*, *accessRights*, *references*, *datasetID*, *institutionCode*, *datasetName*, *ownerInstitutionCode*, *basisOfRecord*, *informationWithheld*, *dataGeneralizations*, *recordedBy*, *individualCount*, *sex*, *lifestage*, *associatedReferences*, *samplingProtocol*, *samplingEffort*, *eventDate*, *verbatimEventDate*, *continent*, *countryCode*, *stateProvince*, *municipality*, *verbatimLocality*, *verbatimCoordinates*, *verbatimCoordinateSystem*, *verbatimSRS*, *decimalLatitude*, *decimalLongitude*, *geodeticDatum*, *coordinateUncertaintyInMeters*, *georeferenceRemarks*, *identificationVerificationStatus*, *scientificName*, *kingdom*, *phylum*, *class*, *order*, *taxonRank*, *scientificNameAuthorship*, *vernacularName*, *nomenclaturalCode*.

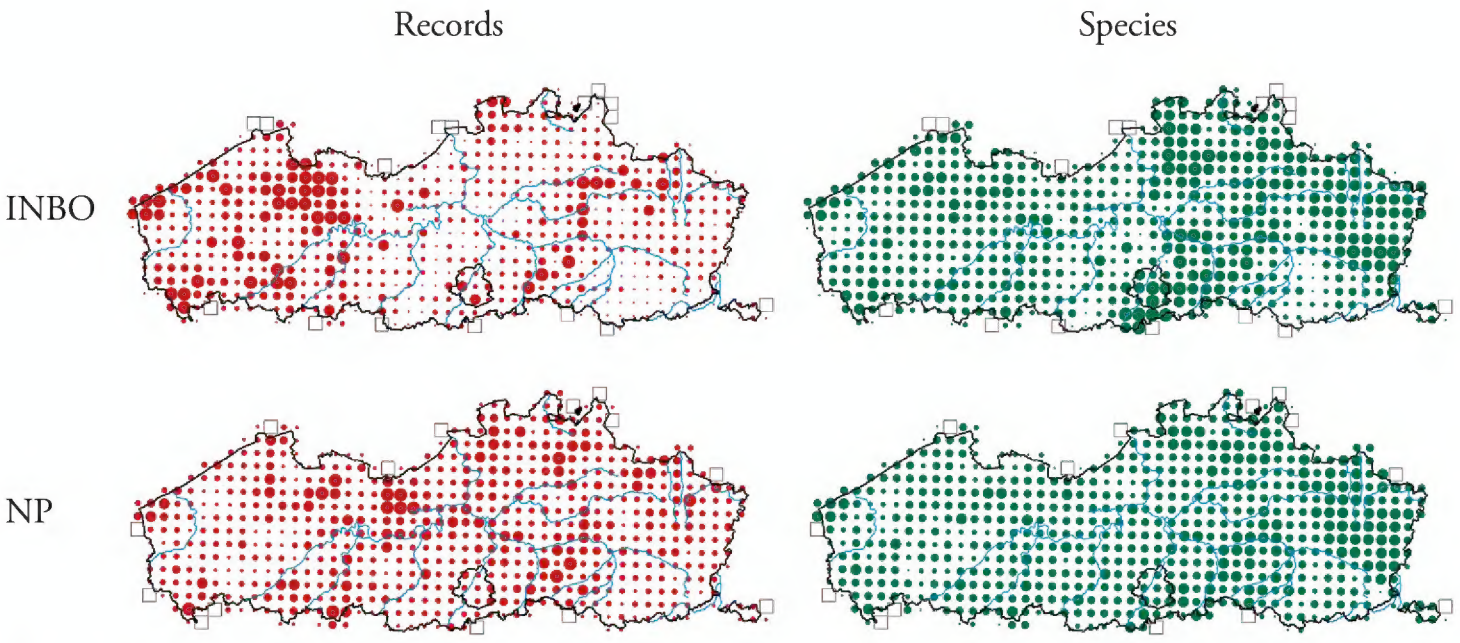

Figure 5. Number of records (left, increasing dot sizes represent 100, 1000, 2500, 5000 and >5000 records per grid cell) and species (right, increasing dot sizes represent 10, 20, 30, 40 and >40 species per grid cell) in the INBO dataset (1830–2014, top row) and in the NP dataset (1981–2014, bottom row). Squares indicate grid cells without records.

INBO dataset

- **Object name:** Vlinderdatabank – Butterflies in Flanders and the Brussels Capital Region, Belgium
- **Format name:** Darwin Core Archive format
- **Format version:** 1.0
- **Character encoding:** UTF-8
- **Language:** English
- **License:** http://creativecommons.org/publicdomain/zero/1.0/
- **Usage norms:** http://www.inbo.be/en/norms-for-data-use
- **Publication date:** 2016-01-13
- **Distribution:** http://dataset.inbo.be/dagvlinders-inbo-occurrences
- **DOI:** http://doi.org/10.15468/njgbmh

Natuurpunt dataset

- **Object name:** Waarnemingen.be – Butterfly observations in Flanders and the Brussels Capital Region, Belgium
- **Format name:** Darwin Core Archive format
- **Format version:** 1.0
- **Character encoding:** UTF-8
- **Language:** English
- **License:** http://creativecommons.org/publicdomain/zero/1.0/
- **Usage norms:** http://www.natuurpunt.be/normen-voor-datagebruik

- **Publication date:** 2016-02-02
- **Distribution:** http://dataset.inbo.be/dagvlinders-natuurpunt-occurrences
- **DOI:** http://doi.org/10.15468/ezfbee

Usage norms

To allow anyone to use the datasets described here, we released the data to the public domain under a Creative Commons Zero waiver (http://creativecommons.org/publicdomain/zero/1.0/). Users of published datasets are encouraged to follow the respective norms for data use (http://www.inbo.be/en/norms-for-data-use and http://www.natuurpunt.be/normen-voor-datagebruik [in Dutch]) and to provide a link to the original dataset (http://doi.org/10.15468/njgbmh and http://doi.org/10.15468/ezfbee), whenever appropriate. If used for a scientific paper, it is recommended to cite the dataset following the applicable citation norms (e.g. GBIF 2012) and/or to contact the authors for additional information (dirk.maes@inbo.be, marc.herremans@natuurpunt.be or dimitri.brosens@inbo.be). Dataset issues can also be reported via opendata@inbo.be.

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References

Beckers K, Ottart N, Fichefet V, Godeau JF, Weyembergh G, Beck O, Gryseels M, Maes D (2009) Dagvlinders van het Brussels Hoofdstedelijk Gewest: verspreiding, behoud en beheer/Papillons de jour de la Région de Bruxelles-Capitale: répartition, conservation et gestion, Leefmilieu Brussel & Instituut voor Natuur- en Bosonderzoek, Brussel, 158 pp.

Cuvelier S, Degrande J, Merveillie L, Spruytte S, Vervaeke J (2007) Dagvlinders in West-Vlaanderen. Verspreiding en Ecologie 2000–2006, Z.W.V.V.K., Ieper, 144 pp.

Daniëls L (1991) JNM-Dagvlinderprojekt. Euglena 10: 26–27.

De Prins W (1998) Catalogue of the Lepidoptera of Belgium, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel, 235 pp.

De Selys-Longchamps E (1837) Catalogue des Lepidoptères ou Papillons de la Belgique. Luik, 14–21.

GBIF (2012) Recommended practices for citation of the data published through the GBIF Network. Version 1.0 (Authored by Vishwas Chavan), Global Biodiversity Information Facility, Copenhagen, 12 pp.

Hackray J, Sarlet L, Berger L (1969) Catalogue des macrolépidoptères de Belgique. Lambillionea (suppl.) 67: 1–256.

Kühn E, Feldmann R, Harpke A, Hirneisen N, Musche M, Leopold P, Settele J (2008) Getting the public involved in butterfly conservation: Lessons learned from a new monitoring scheme in Germany. Israel Journal of Ecology & Evolution, 54: 89–103. doi: 10.1560/IJEE.54.1.89

Maes D, Van Dyck H (1999) Dagvlinders in Vlaanderen - Ecologie, verspreiding en behoud, Stichting Leefmilieu i.s.m. Instituut voor Natuurbehoud en Vlaamse Vlinderwerkgroep, Antwerpen/Brussel, 480 pp.

Maes D, Van Dyck H (2001) Butterfly diversity loss in Flanders (north Belgium): Europe's worst case scenario? Biological Conservation 99: 263–276. doi: 10.1016/S0006-3207(00)00182-8

Maes D, Vanreusel W, Jacobs I, Berwaerts K, Van Dyck H (2012) Applying IUCN Red List criteria at a small regional level: A test case with butterflies in Flanders (north Belgium). Biological Conservation, 145: 258–266. doi: 10.1016/j.biocon.2011.11.021

Maes D, Vanreusel W, Van Dyck H (2013) Dagvlinders in Vlaanderen: nieuwe kennis voor betere actie, Uitgeverij Lannoo nv, Tielt, 542 pp.

Robertson T, Doring M, Guralnick R, Bloom D, Wieczorek J, Braak K, Otegui J, Russell L, Desmet P (2014) The GBIF Integrated Publishing Toolkit: Facilitating the Efficient Publishing of Biodiversity Data on the Internet. PLoS ONE 9: e102623. doi: 10.1371/journal.pone.0102623

van Swaay CAM, Nowicki P, Settele J, van Strien AJ (2008) Butterfly monitoring in Europe: methods, applications and perspectives. Biodiversity and Conservation 17: 3455–3469. doi: 10.1007/s10531-008-9491-4

van Swaay CAM, Termaat T, Plate CL (2011) Handleiding Landelijke Meetnetten Vlinders en Libellen, Rapport VS2011.001. De Vlinderstichting & Centraal Bureau voor de Statistiek, Wageningen/Den Haag, 27 pp.

Vriens L, Bosch H, De Knijf G, De Saeger S, Oosterlynck P, Guelinckx R, T'jollyn F, Van Hove M, Paelinckx D (2011) De Biologische Waarderingskaart. Biotopen en hun verspreiding in Vlaanderen en het Brussels Hoofdstedelijk Gewest, Mededelingen van het Instituut voor Natuur- en Bosonderzoek INBO.M.2011.1. Instituut voor Natuur- en Bosonderzoek, Brussel, 416 pp.

Watt WB, Boggs CL (2003) Butterflies as model systems in ecology and evolution - Present and future. In: Boggs CL, Watt WB, Ehrlich PR (Eds) Butterflies: Ecology and evolution taking flight. The University of Chicago Press, Chicago, 603–613

Wieczorek J, Bloom D, Guralnick R, Blum S, Doring M, Giovanni R, Robertson T, Vieglais D (2012) Darwin Core: An Evolving Community-Developed Biodiversity Data Standard. PLoS ONE 7: e29715. doi: 10.1371/journal.pone.0029715

Wieczorek J, Guo QG, Hijmans RJ (2004) The point-radius method for georeferencing locality descriptions and calculating associated uncertainty. International Journal of Geographical Information Science 18: 745–767. doi: 10.1080/13658810412331280211

Supplementary material 1

A database on the distribution of butterflies (Lepidoptera) in northern Belgium (Flanders and the Brussels Capital Region)

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Data type: Additional references

Explanation note: The supplementery material provides 1) a list of published entomological references that were checked for occurrence data and 2) a list of references that used data described in this paper.

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